ICTMA Newsletter

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The International Community of Teachers of Mathematical Modelling and Applications.
www.ictma.net

The Community, through its membership, research and other activities, is recognised as "The International Study Group for Mathematical Modelling and Applications (ICTMA)" by its affiliation to the International Commission on Mathematical Instruction (ICMI).

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Contents

Please send future contributions to the editor by email <g.stillman@unimelb.edu.au>. The next Newsletter will be published in December, 2009. We are interested in your contributions to any of the current sections.

1. International Executive Committee

Following the business meeting in Hamburg on July 30, 2009, the ICTMA Executive for 2009-2011 was confirmed as follows:

President
Prof Gabriele Kaiser (Germany)
Past Conference Organisers
Richard Lesh (USA)
Rita Borromeo Ferri (Germany)
Elected Members
Toshikazu Ikeda (Japan) – Registrar
Thomas Lingefjärd (Sweden)
Gloria Stillman (Australia) – Newsletter Editor & Secretary
Co-opted Members
Jonei Barbosa (Brazil)
Katja Maaß (Germany)
Jinxing Xie (China) – Webmaster & List Serve Moderator

2. CERME Activities

2.1 Working Group 11: Applications and Modelling

CERME 6 took place in Lygon, France, form January, 28 to February, 1, 2009. The thematic group on Applications and Modelling was chaired by Morten Blomhoej of Denmark supported by Susana Carreira, Katja Maass and Geoff Wake. In the spirit of CERME the working group sought to build on and progressively develop the ideas and theoretical discussions from CERME 4 and 5, the latter being reported in an earlier ICTMA Newsletter. A substantial part of the work done at CERME 4 can be found in the two *ZDM* 2006 issues on modelling and applications, no. 2 and 3, Vol. (38).

The aim of the working group was to present and discuss recent research within the area of teaching and learning involving mathematical modelling and applications and their role in mathematics education. The scope included all levels and branches of mathematics teaching–elementary school, secondary or high school, college and university as well as the transitions between levels.

Submitted papers included the following:

- **Richard Cabassut** (France) *The Double Transposition in Mathematisation at Primary School*.

3. Forthcoming ICTMA Conferences

The ICTMA group has held biennial meetings since 1983. This conference series provides a forum for discussing all aspects of teaching applications and mathematical modelling in all areas and at all levels of mathematics education – from primary to secondary schools, at colleges and universities. The next two ICTMA Biennial conferences will be ICTMA 15 in Melbourne, Australia in 2011 and ICTMA 16 in Blumenau, Brazil in 2013.

15TH INTERNATIONAL CONFERENCE ON THE TEACHING OF MATHEMATICAL MODELLING AND APPLICATIONS (ICTMA15)

The 15th ICTMA Conference - ICTMA15 - will be hosted by the University of Melbourne and the Australian Catholic University, Melbourne. It will be organised by Dr Gloria Stillman (Chair and Program Convenor) and Jill Brown (Chair and General Convenor). The conference is scheduled for July 2011.

Conference Theme:

Mathematical Modelling: Connecting to Practice – Teaching practice and the practice of applied mathematicians.

This conference brings together international experts in a variety of fields as well as local and regional teachers, post-graduate students and academics.

Academic programme includes:

- Plenaries by internationally acclaimed speakers
- Paper Presentations [research, theory, & practice]
- Workshops
- Symposium & Poster Sessions for tertiary students - pre-service teachers, post-graduate students in maths education & mathematical modelling
- Modelling Challenge for school students (primary & secondary)

The following themes will be the focus:

- Modelling and applications in business, the environment, industry and the workplace
- Evaluation of effectiveness of such modelling
- Pedagogical issues for teaching and learning
- Applicability at different levels of schooling and in tertiary education
- Research into teaching and practice
- Innovative practices in research, teaching and practice
- Influences of technology
- Assessment in schools and universities

Confirmed Plenary Speakers:

Prof Dr Gabrielle Kaiser, University of Hamburg, Germany

Adjunct Prof Peter Galbraith, University of Queensland, Australia (Ken Houston Honorary Lecture)

Conference venue:

The conference will begin at the Parkville campus of the University of Melbourne and then St Patrick's Campus of ACU (Melbourne). Both campuses are located in inner Melbourne.

The Universities:

The University of Melbourne was established in 1853 and teaching commenced in 1854. It is the second oldest university in Australia. The main campus is located in Parkville on the outskirts of the Central Business District of Melbourne. UM has over 35000 students supported by 7200 staff. Melbourne University is the second largest research organisation in Australia after the Commonwealth Scientific and Industrial Research Organisation. It is easily reached by bus and tram with a super stop located in Swanston Street. It is close to the well known restaurant lined Lygon Street, Carlton.

Australian Catholic University commenced operation in 1991 after the amalgamation of four Catholic institutions of higher education. ACU has an enrolment of 17000 students nationally with 1200staff. Melbourne (St Patrick's) campus is close to the Central Business District, and is a short walk from the University of Melbourne. It can be easily reached by tram and bus. It is close to the well known restaurant area in Brunswick Street, Fitzroy.

Both universities are public universities funded by the Australian Government.

Conference fee:

The conference fee will be approximately AUD 650 (400 €) with day registrations for teachers possible. Depending on sponsorship limited reductions for post-graduate students may be available. The full fee includes the conference dinner, excursion, morning and afternoon teas, lunches, the CD and the post conference book.

Accommodation:

There is a range of accommodation available ranging from superior hotels such as the Windsor and Hyatt, budget hotels such as the Ibis, and backpacker and student accommodation. These are all easily accessible to both Universities by tram or walking.

The City:

Melbourne is the capital city of the state of Victoria and the second most populated city in Australia. The population of Greater Melbourne and the Melbourne city is approaching 4 million. Melbourne was established in 1835 around the estuary of the Yarra River. It is situated on Port Phillip Bay. It is renowned for its shopping, good food and wine, galleries and theatres.

Transport

Melbourne is easily reachable by its internationally connected airport, Tullamarine. A taxi fare to the inner city would cost approximately AUD$40. However, there are cheaper methods of transport to the city heart where you will most likely be staying such as Jetbus Airport Shuttle (book on-line) and Skybus which drop passengers off at particular hotels and motels. There is also a public transport Metlink bus to the city. Rental cars are available at the airport. If you wish to use a limousine you need to book these ahead of time and you will be met by the driver as you clear customs. Australia has very strict customs laws so please declare anything you bring in or dispose of it in the bins provided and you will have fewer hassles.

For further information, please email the conference organisers: Gloria Stillman <g.stillman@unimelb.edu.au> and Jill Brown <jill.brown@acu.edu.au>

Australian Conferences in July: Mathematics Education Research Group of Australasia (MERGA) and Australian Association of Mathematics Teachers (AAMT) will hold conferences in Alice Springs in July 2011. This could be a combined conference. Visit www.merga.net.au and www.ammt.edu.au for further details.

4. Report from ICTMA 14

ICTMA 14 was hosted by the Working group on Didactics of Mathematics within the Faculty of Education at the University of Hamburg. The five day program from July 27 to 31, 2009, was very successful both academically and socially.

Due to generous sponsorship from the German Research Society (GDM), the University of Hamburg and the Faculty of Education at the University of Hamburg, it was possible to offer reductions in registrations for several young researchers and to sponsor researchers from developing countries. It was also pleasing to see that a number of school teachers from countries such as Australia, Japan, Portugal, Spain and Venezuela attended and/ presented. A total of 150 participants attended coming from 29 countries representing all 8 continents. There was a strong contingent of researchers from Germany as well as sizeable groups from Scandinavia (Finland, Sweden and Denmark in particular), China, Brazil and Australia.

President opens the Conference

The scientific program was particularly stimulating with plenary lectures from internationally renowned speakers followed by a response from a local discussant. The Plenary lectures and discussants were as follows:

1. *Can Modelling be Taught and Learnt? Some Answers from Empirical Research* - Prof. Werner Blum, University of Kassel, Germany; Discussant: Marcelo de Carvalho Borba, State University of Sao Paulo at Rio Claro, Brazil

2. *Applying Metacognitive Knowledge and Strategies in Applications and Mathematical Modelling Tasks at Secondary School* - Dr Gloria Stillman, University of Melbourne, Australia; Discussant: Dr Rita Borromeo Ferri, University of Hamburg, Germany

3. *Mathematical Modelling and a New Role for Mathematics as Key Technology* - Prof. em. Dr Helmut Neunzert, Fraunhofer Institute for Technology and Economathematics (ITWM), Kaiserslautern, Germany; Discussant: Prof Jens Struckmeier, University of Hamburg, Germany

4. *Drivers for Mathematical Modelling: Pragmatism in Practice* – Prof Chris Haines, City University, London, UK; Discussant: Katja Maas, Educational University, Freiburg, Germany

5. *Models and Modelling: Perspectives on Teaching and Learning Mathematics for the 21st Century* – Prof Richard Lesh, Indiana University, USA, and Prof Helen Doerr, Syracuse University, USA

A total of 98 papers including plenaries were presented at the conference. These were grouped in themes in parallel sessions. Themes included Teacher Education, Examples, Competencies, Empirical Research, Curricular Aspects, Technology, Theoretical Reflections, Projects, and Cognitive Aspects. Another feature was that on the last day of the conference a panel discussion was held on the theme: *Modelling perspectives around the world – state of the art*.

Beside the scientific programme some other activities were organised to show the participants the city of Hamburg. One highlight was the reception of the state of Hamburg in the wonderful "Kaisersaal" in the town hall. This was followed by a boat trip on the harbour including dinner was organized. The conference dinner on the museum ship "Rickmer Rickmers" showed participants around the world, that Hamburg has an international flair in cuisine, dancing and decor.

ICTMA has a tradition of publishing a book that emanates from the conference. Anyone who made a presentation is eligible to submit an 9 page paper for consideration for publication. Further details of formatting requirements and a template are available on the conference website. These papers are peer reviewed by the editors and a panel of international experts. As in the case of the ICTMA 13 publication, Springer will be the publisher of this book. The proposed title is **Trends in Teaching and Learning of Mathematical Modelling**. The editors are Professor Gabriele Kaiser (University of Hamburg, Germany), Professor Werner Blum (University of Kassel, Germany), Dr Rita Borromeo-Ferri (University of Hamburg, Germany) and Dr Gloria Stillman (University of Melbourne, Australia).

Prof. Gabriele Kaiser and Dr. Rita Borromeo-Ferri
Conference Organisers, ICTMA 14, University of Hamburg

5. Brief News Items

5.1 ICMI Study on Educational Interfaces between Mathematics and Industry [EIMI]

The deadline for submissions to the 20th ICMI Study Conference has been extended to October 15, 2009. The EIMI-Study is organized jointly by the International Commission on Mathematical Instruction (ICMI) and the International Council for Industrial and Applied Mathematics (ICIAM). It seeks to better understand the "intimate connections between innovation, science, mathematics and the production and distribution of goods and services in society" and to offer ideas and suggestions on how education and training can contribute to enhancing both individual and societal developments.

This Study is needed:

• to create new and innovative educational practices and support existing good practices,
• to ensure that, when used as an employment selection tool, Mathematics is used appropriately,
• to develop in learners the mathematical reasoning and logical thinking needed in industry,
• to enhance the dialogue and understanding between the communities of mathematicians, workers and industry decision makers, politicians, and educators.

Sub themes of the conference are (5-9 are, in our view, of particular interest for ICTMA):

1) The role of mathematics – visibility & black boxes
2) Examples of use of technology and
3) Communication and collaboration
4) Teaching and learning of industrial mathematics – making industrial mathematics more visible
5) Using Technology and learning with technology: Modelling & Simulation
6) Teaching and learning for communication and collaboration
7) Curriculum and syllabus issues
8) Teacher training
9) Good practices & lessons to be learned

Study Timeline Submissions for participation in the Study should be sent in by October 15, 2009. Submissions will be reviewed and decisions made about inclusion in the Conference Proceedings. Notifications about these decisions will be sent by November 15, 2009 to all those who sent in submissions. In the case of papers accepted for the conference, some suggestions for changes may be sent to the authors. Final versions of papers accepted for the conference proceedings must be received by March 15, 2010. The conference will be held 19 – 24 April, 2010, in Lisboa, Portugal.

Henk van der Kooij.

6. Reports from Regional Areas

6.1 Modelling – Topic of AME Mathematics Teachers' Conference in Singapore in June

On June 4, 2009, the Singapore Association of Mathematics Educators held its fifth Mathematics Teachers Conference organised jointly with the Mathematics and Mathematics Education Academic group at the National Institute of Education (NIE). The theme of the conference was Mathematical Applications and Modelling. Mathematical modelling is one of the processes introduced in the 2007 revised mathematics framework for Singapore. The ICTMA president, Professor Gabriele Kaiser, set the tone for the conference when she gave the opening keynote lecture on *Mathematical Modelling in School - Examples and Experiences*. Gabriele also gave a workshop for secondary school and junior college teachers on *Mathematical modelling in lower secondary level*. Gloria Stillman was also an invited keynote speaker. Gloria spoke on *Implementing Applications and Modelling in Secondary School: Issues for Teaching and Learning.* She followed this up with a workshop, *Designing and using modelling tasks at the secondary school level.* Other keynote lectures were presented by Barry Kissane (*Using ICT for Applications of Mathematics*) and Jayuthsing Dindyal (*Models and modelling in mathematics at the primary level*). The conference was very successful with many teachers and academics attending. For more details of the Association of Mathematics Educators in Singapore visit their website, ***http://math.nie.edu.sg/ame/.*** Keynote presentations are available for download from this site.

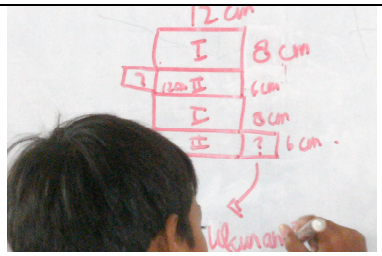
President of AME, Berinderjeet Kaur, with Keynote and other invited speakers.

Photo Source: Association of Mathematics Educators, Singapore

6.2 A Preliminary Glimpse into Realistic Mathematics Education in Indonesia

A team of educators from the Mathematics and Mathematics Education Academic Group at the National Institute of Education visited Universitas Sriwijaya at Palembang, South Sumatra, Indonesia, in April 2009 for a regional seminar on mathematics education. Presenters from both countries provided an overview of the current stage of development of mathematics curricula and mathematics education

research. In particular, the progress of the Realistic Mathematics Education movement in Indonesia, also known as Pendidikan Matematika Realistik Indonesia (PMRI), was reported. Spearheaded by Professor Robert Sembiring in collaboration with Dutch educators from the Freudenthal Institute and APS International, this bottom-up movement began in mathematics classrooms at Indonesian primary schools. In short, realistic mathematics is interpreted by Indonesians as "activity and connection with the world around us" (Lee, 2009).



Using the design-based methodology, mathematics educators have worked with selected teachers in schools to redesign teaching materials at the primary level incorporating real-world elements. Such materials are delivered through activity-based learning. Teachers and teacher educators work collaboratively through the cycle of design, teaching experiment and retrospective analysis to design a learning trajectory for a mathematical lesson and to establish classroom norms to support this. Research-based evidence on this effort are currently being collected and studied. To date, regional centres have been set up in many areas of Indonesia where PMRI research in mathematics teaching and teacher education are the focus. There is also a gradual increase in PMRI-related postgraduate programmes offered by Indonesian universities and subsequent associated publications. As the report "PMRI – Majulah!" (Ekholm & van den Hoven, 2009) suggests and given the vast resources and diverse cultural background of dynamic Indonesia, PMRI may well lead the way for curriculum reforms and change in classroom practice across subjects in the country.

References

Lee, P. Y. (2009). *My story of Realistic Mathematics in Indonesia*. Singapore: National Institute of Education.

Ekholm, M., & van den Hoven, G. H. (2009). *PMRI - Majulah!: Report of the DO-PMRI international advisory board*. Indonesia: Zet&Print, Naarden.

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7. Project Reports

7.1 Curriculum Change in Secondary Mathematics [CCiSM]

Applications and mathematical modelling have remained on the periphery of actual classroom practice in many countries (Blum et al., 2002) even where systems and curriculum documents ostensibly support their inclusion (Stillman, 1998). Despite worldwide use and interest in this approach, little research (Niss, 2001) has been conducted into the paths of curriculum change to support its sustained implementation or the conditions that promote or impede this. In Australia each state has its own education system with distinctive curriculum and assessment policies although now there is a National Curriculum Board and a National Curriculum in mathematics being formulated at the moment. In the past there have been concerted efforts in several Australian states to include applications and mathematical modelling more centrally within the curriculum. Although the notion of applications has been around for a long time, mathematical modelling has been a more recent inclusion in Australian curriculum documents (e.g., VISE, 1985; VCAB, 1990; BSSSS, 1992).

A study has been conducted into curriculum change and current classroom practice re applications and mathematical modelling in two Australian states, namely, Victoria and Queensland, where the path of curriculum change has been markedly different with markedly different outcomes. This is the first phase of a three-phase research program into curriculum change and classroom culture and practice relating to the teaching of applications and mathematical modelling at the senior secondary level. This first phase involved exploratory case studies to determine (a) beliefs about curriculum change held by key people in the implementation of the curriculum in two of the Australian states that have emphasised applications and mathematical modelling in some form in the past and continue to do so and (b) current classroom practice in selected classrooms in those states. Data were collected by document analysis, a series of selective interviews of key curriculum people and practising teachers, and collection of classroom artefacts. The inclusion of teacher designed or selected tasks has provided corroborative detail to supplement self-report data provided by teachers in interviews.

Gloria Stillman

References

Blum, W., et al. (2002). ICMI Study 14: Applications and modelling in mathematics education - discussion document. *Educational Studies in Mathematics, 51*, 149-171.

Board of Senior Secondary School Studies (BSSSS). (1992). *Senior Mathematics B*. Brisbane, Australia: Author.

Niss, M. (2001). Issues and problems of research on the teaching and learning of applications and modeling. In J. F. Matos, W. Blum, S. K. Houston, & S. P. Carreira (Eds.), *Modelling and mathematics education*. Chichester: Horwood.

Stillman, G. A. (1998). The emperor's new clothes? Teaching and assessment of mathematical applications at the senior secondary level. In P. Galbraith, W. Blum, G. Booker., & I. Huntley (Eds.), *Mathematical modelling: Teaching and assessment in a technology rich world* (pp. 243-253). Chichester: Horwood Publishing.

Victorian Curriculum and Assessment Board (VCAB). (1990). *Mathematics study design*. Melbourne, VIC: Author.

Victorian Institute of Secondary Education (VISE). (1985). *Higher School Certificate Course Description: Mathematics Group 1*. Melbourne, VIC: Author.

Selected Research Publications from project:

Stillman, G. (2004). Sustained curriculum change: The example of the implementation of applications and modelling curricula in two Australian states. In H-W. Henn & W. Blum (Eds.), *Proceedings of the ICMI study 14: Applications and modelling in mathematics education* (Pre-Conference Vol., 261-266). Dortmund, Germany: Department of

Stillman, G. (2007). Implementation case study: Sustaining curriculum change. In W. Blum, P. Galbraith, M. Niss, H.-W. Henn (Eds.), *Modelling and applications in mathematics education, New ICMI Studies Series no. 10* (pp. 497-502). New York: Springer.

Stillman, G., & Galbraith, P. (2009). Softly, softly: Curriculum change in applications and modelling in the senior secondary curriculum in Queensland. In R. Hunter, B. Bricknell & T. Burgess (Eds.), *Crossing divides, Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (MERGA) (pp. 515-522). Adelaide: MERGA. [Available from: www.merga.net.au]

8. Recent Dissertations

Busse, A. (2009). Empirische Untersuchung zur Rolle des Sachkontextes bei realitätsbezogenen Mathematikaufgaben Doctoral thesis. University of Hamburg, Germany. Supervisor: Prof Dr Gabriele Kaiser. The dissertation has been published as follows: Busse, A. (2009). *Umgang Jugendlicher mit dem Sachkontext realitätsbezogener Mathematikaufgaben. Ergebnisse einer empirischen Studie*. Hildesheim, Berlin: Franzbecker.

It is a widely shared opinion within the scientific and educational community that realistic tasks constitute an essential element in the mathematics classroom. A characteristic feature of this kind of tasks is their embedment in a certain realistic background, the real world context. Whilst it seems to be commonly agreed upon that familiar real world contexts usually have a fostering effect on primary school children the situation seems different for teenage students. Members of this age group tend to interpret given real world contexts more individually so that possible contextual effects cannot be predicted as easily for them as they can for younger children. In the qualitative-orientated empirical study that was conducted, a focus was put on how upper secondary students deal with real world contexts. Since these students often handle real world contexts in individual ways, a special methodical approach was necessary. This approach was to allow insight into both, the individual mathematical work on the problem and possible internal processes caused by the real world context. Therefore a three-step-design consisting of observation, stimulated recall and interview was developed, which enabled the researcher to reconstruct different levels of action separately although they have taken place simultaneously. This methodical approach is regarded as a triangulation of methods; consequently, the data analysis takes this aspect into consideration.

It was found that a real world context given in a task is not only interpreted very individually but is also dynamic in a sense that the contextual ideas change and develop during the process of working on the task. Furthermore, the data analysis led to four different ideal types of dealing with the real word context: *reality bound*, *integrating*, *mathematics bound*, and *ambivalent*. Based on the theoretical background of situated learning these ideal types can be understood as effects of – often implicitly given – socio-mathematical norms concerning the permissible amount of extra-mathematical reasoning when working on a mathematical problem. The results of the study show the importance of an individualised view on students' different ways of dealing with real world contexts. Moreover, the relevance of an explicit teaching of socio-mathematical norms in the application and modelling classroom has to be emphasised.

Ng, Kit Ee Dawn (2009). *Thinking, small group interaction and interdisciplinary project work*. Unpublished PhD thesis. The University of Melbourne, Victoria, Australia. Supervisors: Dr Gloria Stillman & Prof Kaye Stacey.

Interdisciplinary Project work (PW) was introduced as an educational initiative in Singapore schools from primary to pre-university levels in 2000. PW is claimed to (a) enhance perceptions and use of inter-subject connections in real world problems,(b) promote knowledge application, and (c) provide a platform for the use of thinking skills. The main goal of this thesis was to explore how these objectives were inter-related with factors influencing the quality of group collaborative mathematical thinking processes and mathematical outcomes during a mathematically-based interdisciplinary project. In this study, high quality mathematical thinking processes occurred when the flow of group interactions was purposefully directed towards the enhancement of mathematically accurate, logical, and reasonable outcomes. A Sequential Explanatory Mixed Method Design consisting of consecutive quantitative and qualitative data collection and analysis procedures was used. A researcher-designed mathematically-based interdisciplinary project was implemented over 14-15 weeks with 16 classes of students (aged 13-14) belonging to two educational streams (higher and average-ability) in three Singapore government schools. No teaching intervention was administered. Six scales were developed for pre- and post- project measurements of students' mathematical confidence, perception of the value of mathematics, and perception of the interconnectedness of mathematics (N = 398). Ten student-group cases (n = 38) were selected for further in-depth qualitative data collection procedures pertaining to the nature of mathematical knowledge application, use of metacognitive monitoring and regulatory strategies, and core thinking skills application during three tasks in the interdisciplinary project.

The findings of this study clearly demonstrate the complexities of using PW to promote holistic and connected use of knowledge. Five substantial contributions to research on interdisciplinary learning arise from the thesis:

- An empirical framework synthesising factors influencing the quality of group collaborative mathematical knowledge application and outcomes was developed.
- The social influence of the group member activating applications of core thinking skills and metacognitive monitoring and regulatory strategies acts as a mediating factor influencing the flow of cognitive-metacognitive group interactions, and therefore, the quality of collaborative mathematical knowledge application processes and outcomes.
- Leaders of high stream groups who were socially non-dominant but mathematically active were more likely to apply a higher frequency of core thinking skills than group members in other roles (i.e., questioner, recorder, and encourager) during a mathematically-based interdisciplinary project.
- The types and complexities of mathematical knowledge and skills applied during a mathematically-based interdisciplinary project did not correspond with stream.
- Whilst students were more able to appreciate the use of mathematics for inter-subject learning after participating in a mathematically-based interdisciplinary project, their beliefs about inter-subject connections and efforts at making these connections changed only marginally.

These outcomes enhance our understanding of the challenges involved in the successful use of interdisciplinary tasks with middle school students and provide focuses for future teacher facilitation of mathematical learning during interdisciplinary education.

9. Recent Publications of Interest

Ang, K. C. (2006). Mathematical modelling: Technology and H3 mathematics. *The Mathematics Educator, 9*(2), 33-47.

Ang, K. C. (2009). Mathematical modelling and real life problem solving. In B. Kaur, B. H. Yeap M. Kaur (Eds.), *Mathematical problem solving* (pp. 159-182). Singapore: World Scientific.

Bergman Ärlebäck, J. (2009). On the use of realistic Fermi problems for introducing mathematical modelling in school. The Montana *Mathematics Enthusiast, 6*(3), 331-364.

The author uses an analytical tool, the MAD (Modelling Activity Diagram) framework, adapted from Schoenfeld's parsing protocol coding scheme to address the issue of how to introduce mathematical modelling to upper secondary students. The work of three groups of students engaged in solving "realistic" Fermi problems were analysed using the framework. It was observed that the processes involved in a typical mathematical modelling cycle were richly represented in the groups' solving processes. The importance of social interactions within the groups was noted, as well as the extensive use of extramathematical knowledge used by the students during the problem solving session.

Chan, C. M. E. (2008). Using modeling-eliciting activities for primary mathematics classrooms. *The Mathematics Educator, 11*(1/2), 47-66.

Chalmers, C. (2009). Group metacognition during mathematical problem solving. In R. Hunter, B. Bricknell & T. Burgess (Eds.), *Crossing divides*, Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia (MERGA) (pp. 105-112). Adelaide: MERGA. [Available from: www.merga.net.au]

Garii, B., & Okumu, L. (2008). Mathematics and the world: What do teachers recognise as mathematics in real world practice. *The Montana Mathematics Enthusiast, 5*(2/3), 291-304.

Griffiths, M. (2009). The immortal ant and the expanding balloon. *Teaching Mathematics and its Applications, 28*(3), 150-158.

Heck, A., Houwing, H., & de Beurs, C. (2009). An e-class in action: Experiences with ICT-intensive teaching and learning of discrete dynamical models at secondary school. *Electronic Journal of e-Learning,* 7(1), 41–52. [Available from: www.ejel.org]

In 2007, a small team of university and secondary school teachers in the Netherlands jointly developed and piloted an e-class for 4th and 5th grade Dutch secondary students (aged 16-17yrs) at both pre-university and general vocational level. The goal was to develop and test innovative ways of teaching mathematics that would enable schools to offer optional courses for small numbers of students. The e-class was web-supported instruction in a blended learning approach. The instructional material consisted of a chapter on discrete dynamical models from a new textbook, supplemented by investigative activities. Students could build and simulate dynamical models with the computer learning environment Coach. Instructions for learning to work with software were given through screen casts created by the teacher to gear with students' needs and made available in the Sakai-based virtual learning environment. Students received weekly on-line assignments submitted digitally. At

home they could receive assistance from peers and the teacher in a chat room. The authors discuss some of the e-ingredients of the e-class and their potential for teaching and learning mathematics and science in terms of principled design approaches to multimedia learning and pedagogical arrangements. They report the experiences of project participants and present future plans.

Hock, C. U. (2008). Introducing mathematical modelling to secondary school teachers: A case study. *The Mathematics Educator, 11*(1/2), 21-32.

Jankvist, U. T. (2009). History of modern applied mathematics in mathematics education. *For the Learning of Mathematics, 29*(1), 8-13.

The author discusses the integration of the history of modern applied mathematics into mathematics education as well as the possibility of teaching and learning beefits acruing from introducing a newer history of mathematics over an older one --- something that seems to be done most often when integrating history into mathematics education. Three cases of the history of modern applied mathematics (i.e., modern applications of mathematics) are presented and later discussed in terms of their possible contributions to the use of 'history as a goal' and 'history as a tool'.

Lind,J. (2009). Real world graph connectivity. *Teaching Mathematics and Its Applications, 28*(3), 159-161.

The topic of graph connectivity is presented along with a famous theorem on Menger in the real-world setting of the national network infrastructure of *National LambdaRail*.

Melendez, B., Bowman, S., Erickson, K., & Swim, E. (2009). An integrative leaning experience within a mathematics curriculum. *Teaching Mathematics and its Applications, 28*(3), 131-144.

Naresh, N., & Presmeg, N. (2009). Characterisation of bus conductors' workplace mathematics: An extension to Saxe's four parameter model. In M. Tzekaki, M. Kaldrimidou & H. Sakonidis (Eds.), *In search for theories in mathematics education*, Proceedings of the 33rd annual conference of the International Group for the Psychology of Mathematics Education (PME) (Vol. 4, pp. 201-208). Thessaloniki, Greece: PME.

Ng, K.E.D., & Stillman, G. (2009). Applying mathematical knowledge in a design-based interdisciplinary project. In R. Hunter, B. Bricknell & T. Burgess (Eds.), *Crossing divides*, Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia (MERGA) (pp. 411-418). Adelaide: MERGA. [Available from: www.merga.net.au]

Perry, Z. H., & Todder, D. (2009). Change in senior medical students' attitudes towards the use of mathematical modeling as a means to improve research skills. *Teaching Mathematics and its Applications, 28*(2), 88-100.

The authors designed a course with the goal of developing the medical students' skills in computerised data analysis and mathematical modelling, as well as enhancing their ability to read and interpret mathematical data analysis. The study evaluated the acquisition of research skills and how to understand such data, as well as evaluating the students' feeling of competence. The course was structured as a 1-week (30-hr) workshop for final year medical students. The study population consisted of 23 medical students who took the course in the 2005 academic year. Course evaluation used questionnaires that assessed the students' satisfaction and mathematical knowledge. A significant change in student attitudes was found, comparing their before and after attitudes towards their competence in the use of mathematical modelling, academically (i.e., their ability to read and understand articles using mathematical models) as well as medically (i.e., their ability to implement theory that arises from mathematical models to medical applications). The authors believe the use of mathematical modelling training in medical education significantly improved the students' confidence in reading and applying mathematical models in medicine; there is a tendency (albeit insignificant) towards superior results in attitudes of students towards mathematics usage in medicine at large.

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